

# Face Detection and Visual Landmarks Approach to Monitoring of the Environment

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## **Abstract**

Many problems of technical vision received a lot of attention recently. In this paper, we consider the problem of monitoring of passenger flows. To solve this problem we use Haar cascades.

**Mathematics Subject Classification:** 42C40, 65T60

**Keywords:** Haar cascades, technical vision, visual landmarks

Many problems of technical vision received a lot of attention recently (see e.g. [1] – [3]). In particular, we can mention problems of robot visual navigation (see e.g. [4] – [11]). In this paper, we consider the problem of monitoring of passenger flows. Note that one of the conditions for effective functioning of the transport complex is the systematic monitoring of passenger flows. We can use passenger detection to solve this task. Haar cascades are traditionally used in the real-time face detection (see e.g. [12]).

Note that visual recognition problems can be divided into two main categories, object recognition and object class recognition. It is clear that the former involves the efficient detection of a specific object with certain visual attributes. In the latter category we try to learn an internal model that corresponds to all objects of a class and we are not looking for a specific instance

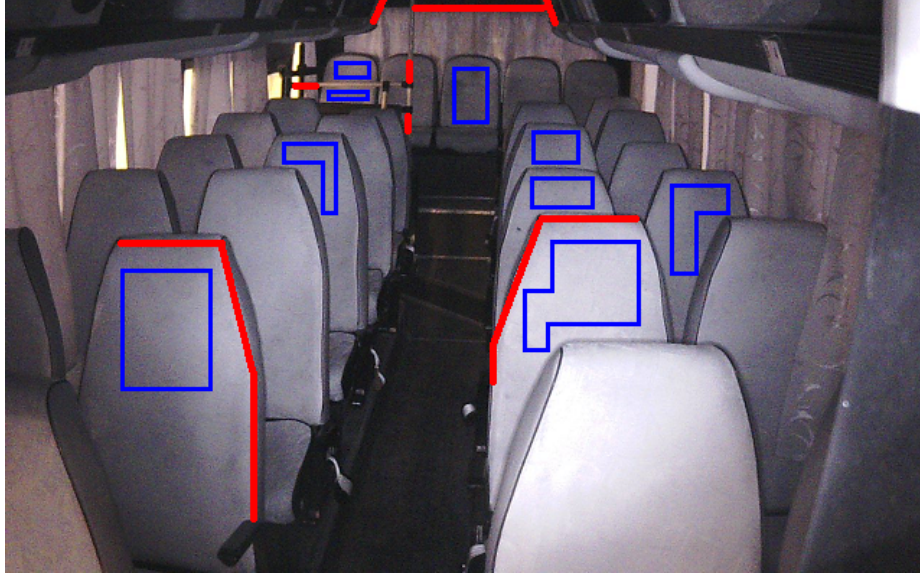


Figure 1: Examples of basic (blue) and additional (red) landmarks.

within a class. Clearly, since detection of any specific passenger is very hard problem, usage of passenger class recognition is more preferable. However, in this case, we need a permanent monitoring of the environment. Note that different problems of landmarks placement are extensively studied recently (see e.g. [13] – [19]). In particular, to solve our problem we can use a visual landmarks approach. As visual landmarks we consider chairs, rail, and some other points of the bus salon (see Figure 1).

We can use simple visual landmarks model. Also, we can consider an intelligent visual landmarks model which allows us to determine quality of visual landmarks and use proper refreshment of visual landmark system.

In our experiments, we consider videos that have been received from one bus camera. As experimental data, we have selected a representative set of samples. We consider the following characteristics of the set, the presence of different numbers of passengers, levels of illumination, levels of camera focus, levels of camera calibration. This characteristics we consider in the following order, increasing the number of passengers and reducing the level of illumination, camera focus, and camera calibration. We obtain a sequence of files

$$F[0], F[1], \dots, F[11].$$

Using visual observation we have obtained the exact number  $Num(F[i])$  of passengers for each  $F[i]$ . For each video  $F[i]$ ,  $1 \leq i \leq 11$ , we consider only images  $F[i, j]$ ,  $0 \leq j \leq 9$ . For any image  $X$  and detector  $Y$ , let  $R(X, Y)$  be the result of detection of passengers on the image  $X$  by the detector  $Y$ .

We consider Haar cascades  $H[2], H[3], H[4], H[5]$  from OpenCV 2.1

haarcascade\_frontalface\_alt.xml,  
 haarcascade\_profileface.xml,  
 haarcascade\_frontalface\_alt\_tree.xml,  
 haarcascade\_frontalface\_alt2.xml,

respectively), Haar cascade based algorithm  $H[0]$  which uses simple visual landmarks model, and Haar cascade based algorithm  $H[1]$  which uses intelligent visual landmarks model. Let

$$N = \frac{\sum_{i=0}^{11} Num(F[i])}{12}.$$

Let

$$P[n] = \frac{\sum_{i=0}^{11} \sum_{j=0}^9 R(F[i, j], H[n])}{120}.$$

Selected experimental results are given in Figure 2.

$n$	0	1	2	3	4	5
$P[n]$	3.91	4.2	2.98	2.01	2.33	3.81

Figure 2: Experimental results for  $N = 10.33$ .

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